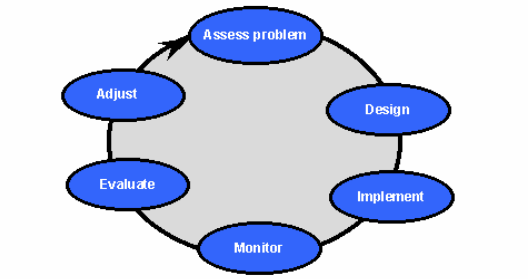
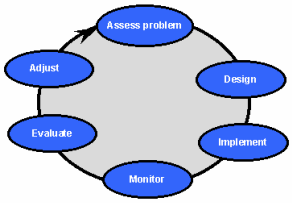


DOI Workshop on Adaptive Management

April 15-16, 2004
National Conservation Training Center
Shepherdstown, WV

Four case studies are presented to examine various aspects of the benefits and challenges of application of adaptive management concepts within the Department of the Interior. These examples encompass efforts from adaptive management of species harvest to three examples of adaptive management of a single management action type (e.g. dam operation, gas field development, fisheries harvest) effecting natural resources or societal values in riparian, terrestrial, and marine settings. These examples represent adaptive management at varying stages of implementation and thus serve to highlight the breadth of policy issues that face the Department as it discusses application of adaptive management's "learn by doing" model versus traditional environmental management models. A series of questions is answered for each case study to help frame why adaptive management was selected as a viable alternative to tradition approaches and the associated policy and implementation concerns.

- management issue that was the primary driver,
- uncertainties that led to AM approach being selected
- monitoring and science framework developed to support AM
- partner, stakeholder involvement versus traditional
- financial cost of implementing AM
- costs or consequences of not applying
- limitations of AM in the case study
- greatest challenges or constraints that have been overcome or that remain
- time line for implementation of AM
- benefits provided by AM to date
- specific best management practices resulting from



Case Study: Adaptive Management of Waterfowl Harvests

Fred A. Johnson, Division of Migratory Bird Management, USFWS
Mike Runge, Patuxent Wildlife Research Center, USGS

Overview – The Migratory Bird Treaty Act (as amended) authorizes the federal government to establish annual regulations governing the sport hunting of waterfowl within the United States. Because of the need to collect and analyze biological data each year, the time available for developing regulatory proposals, soliciting public comment, and setting hunting seasons is extremely limited. Although the regulatory process has worked reasonably well from a biological perspective, it tends to be controversial because of uncertainties and disagreements about the impacts of regulations on harvest and waterfowl abundance. In 1995, the USFWS implemented an approach referred to as adaptive harvest management (AHM), in which managers seek to maximize long-term harvest yield against a background of various

sources and degrees of uncertainty. The key feature of this approach is an explicit accounting for uncontrolled environmental variation, incomplete control over harvest levels, and key uncertainties regarding waterfowl population dynamics. Using stochastic control methodology, regulatory policies are designed to produce both short-term harvest yield, as well as the biological learning needed to improve long-term management performance. This AHM process has proved to be an effective tool for considering the relative risks of alternative management outcomes, and for reducing uncertainty about regulatory impacts.

Management issue that was the primary driver – FWS and State resource agencies (through four Flyway Councils) share decision-making responsibilities over the setting of migratory bird hunting regulations. The rule-making process had become overly contentious because of uncertainties and disagreements about the impacts of regulations on harvest and waterfowl abundance.

Uncertainties that led to AM approach being selected (i.e., the various alternate hypotheses related to the management action – Understanding the nature of density-dependent population growth is the key to sustainable harvesting. Thus, competing hypotheses involve the extent to which survival and reproductive processes of ducks are density-dependent.

Monitoring and science framework developed to support AM – Several aspects of past waterfowl management and research facilitated the development and adoption of the AHM approach and can be viewed as pre-adaptations. With respect to the five components necessary to carry out AHM (clear objectives, management options, a set of competing models, measures of model credibility, a monitoring program), the existence of an excellent monitoring program and a good set of predictive models of system response were probably the two most important pre-adaptations useful in the establishment of AHM. Methodologically, the existence of scientists who were knowledgeable about methods of optimal stochastic control and who wanted to apply these methods to duck harvest management was extremely important to the development of the AHM process.

Partner, stakeholder involvement versus traditional approaches – The AHM process relies much more heavily than previous approaches on the close collaboration of managers and researchers from federal, state and academic arenas. It has been necessary for both researchers and managers to be involved in all phases of the process, yet both maintain distinct responsibilities appropriate to their respective roles in the decision-making process.

Financial cost of implementing AM – The necessary start-up costs for AHM were largely absorbed within existing monitoring, assessment and decision-making programs. However, additional resources and staff in FWS and USGS are needed to sustain and refine the program.

Costs or consequences of not applying AM – If AHM had not been implemented, there would have been continued contentiousness in the rule-making process, progressive erosion of traditional partnerships, and less hunting opportunity over the long-term due to continuing uncertainty about the magnitude of harvestable surpluses.

Limitations of AM in this case – Understanding the large-scale dynamics of migratory bird populations is difficult and is limited by the resolution of extant monitoring programs. The process is passively adaptive; i.e., no probing actions to reduce major uncertainties because the perceived risk to short-term hunting opportunity is too great (biological learning is slow and the strength of inferences limited).

Greatest challenges or constraints that have been overcome or that remain – Competing social values (i.e., management goals & objectives), and the lack of effective procedures for organizing what is essentially a political debate, pose a serious threat to the long-term viability of AHM (or any other informed approach to management). There is an on-going shortage of qualified technical staff for synthesizing available data and understanding the associated management implications. A growing

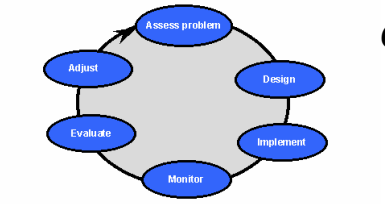
disparity exists between the knowledge-level of people most directly involved in the process and those more indirectly involved, in part due to insufficient resources for information and education efforts.

Time line for implementation of AM –

- 1992: Convened technical working group representing major stakeholders (State agencies, FWS, USGS)
- 1993: Invited outside peer review of proposed conceptual approach
- 1995: FWS director convened administrative/policy level ask force, which recommended immediate implementation; AHM implemented for the 1995-96 hunting season
- 1996-2003: adjustments to harvest strategy based on comparison of predicted and observed responses by duck populations (i.e., adaptation of management strategy)
- 2003: IAFWA convened new task force to explore and make recommendations concerning policy & institutional aspects of AHM as a result of lessons learned since 1995 (sometimes referred to as "double-loop learning")

Benefits provided by AM to date – AHM has resulted in an explicit linkage between operational monitoring programs and management decision-making. It has provided an explicit protocol for modifying actions based on what is learned. Through better predictive models of duck population dynamics, AHM has increased the probability of sustainable harvesting. It has created a coherent, systematic process for understanding the implications of various management goals, objectives, and constraints. These benefits result in greatly reduced contentiousness in the rule-making process and re-affirmation of key partnerships.

Specific best management practices resulting from AM – Duck-hunting regulations have been established each year since 1995 in accordance with the AHM prescription; for the first time, there is a prescriptive strategy based on extant populations and habitat conditions. Harvest strategies continue to evolve to account for what is learned in the process.



Case Study: Adaptive Management of Glen Canyon Dam

Dennis Kubly and Randall Peterson ,Bureau of Reclamation

Overview – The primary function of the Glen Canyon Dam Adaptive Management Program (Program) is to identify and recommend actions to the Secretary of the Interior that can be used both to meet obligations for water delivery and hydropower from Glen Canyon Dam and resource management objectives identified in the Grand Canyon Protection Act. Twenty-five stakeholder representatives serve on a federal advisory committee, the Glen Canyon Adaptive Management Work Group, and a supporting Technical Work Group. The Grand Canyon Monitoring and Research Center (GCMRC), a field station of the U.S. Geological Survey, serves as the science institution for the Program. The primary experimental tool for the Program is Glen Canyon Dam. The 1996 Record of Decision on Glen Canyon Dam operations diminished daily fluctuations for hydropower production and put into place a set of experimental habitat and beach-building releases. In addition to modifying dam releases, the Program is engaged in mechanical removal of non-native fishes from the Colorado River and its tributaries, evaluating the feasibility of using a temperature control device on the dam to warm downstream waters, translocation of endangered fish to expand their distribution, and evaluating sediment augmentation to increase the duration of turbid water as a native fish defense against sight-feeding, piscivorous non-natives. The Program has achieved great success in testing the predictions of the 1995 Environmental

Impact Statement on Glen Canyon Dam operations; however results of ensuing experiments have questioned some of the more important predictions of that document. It remains to be seen whether the existing level of experimentation with this complex ecosystem can ultimately produce desired changes in degraded resources, or whether even larger modifications to management are necessary to achieve these results.

Management issue that was the primary driver – The primary management issue before the Program is to answer the question, "What combination of dam operations and other management actions will meet the statutory requirements of resource protection while continuing to provide other project benefits of dam operations?"

Uncertainties that led to AM approach being selected (i.e., the various alternate hypotheses related to the management action – Although intense scientific research was conducted from 1982 through 1996, significant uncertainties existed with respect to sediment transport (the magnitude and best conservation methods), the endangered humpback chub (lack of recruitment and interactions with non-native fish), cultural resources (most effective means of counteracting natural erosion/gullying), sport fishing (nature and evolution of food base, growth and harvest of trout), and effects of invasive species. EIS and ROD assumed that modifying dam releases could benefit all important natural resources, i.e. decreasing daily fluctuations and ramping rates would provide benefits to natural resources without unduly impacting hydropower production.

Monitoring and science framework developed to support AM – As recommended in the 1996 EIS, the USGS manages a science center that conducts monitoring and research activities. These activities are approved by the management committee and formally recommended to the Secretary of the Interior. Scientific work is conducted through on open Request for Proposal process that includes external peer review of both proposals and reports. In addition, periodic reviews by resource-specific external expert panels ensure Program relevancy and offer suggestions for improving the methods and analysis for conducting science. A science advisory board consisting of nationally acclaimed experts serves to provide general scientific oversight to the Program.

Partner, stakeholder involvement versus traditional approaches – A 25-member management committee organized under the Federal Advisory Committee Act meets several times each year to review the results of monitoring and research activities and make recommendations to the Secretary on additional measures to protect downstream resources. A technical work group serves as a subgroup under the management committee to evaluate results of scientific studies. Each of the stakeholders in the management committee is represented on the technical work group. Partnering with the Department is present within several resource areas. Reclamation and the USGS partner in managing the Program and the Science Center, respectively. Through a recent NEPA evaluation, Reclamation, the USGS and NPS jointly sponsored an experimental effort involving dam releases and non-native fish removal to benefit an endangered fish downstream of the dam. Reclamation and the NPS developed an agreement to jointly address agency undertakings having an adverse effect on cultural resources.

Financial cost of implementing AM – The 1992 Grand Canyon Protection Act authorized funds to meet the costs of monitoring and research related to the effects of dam operations, also allowing the use of power revenues. Currently, additional financial resources are provided through appropriations and NPS fee demo funds in a collaborative effort to protect Grand Canyon resources. The total Program cost is about $10.7 million annually. About $9 million is provided by power revenues. An additional $1 million is appropriated by the USGS, but that arrangement may end in 2005. About $200,000 is provided through NPS fee demo funds. Each DOI bureau involved in the Program contributes $95,000 annually to support tribal participation and government-to-government consultation.

Costs or consequences of not applying AM – Consequences would be: inability to have concluded the EIS ROD; lack of a dedicated and consistent research and monitoring program with feedback to managers

for policy decisions; decision-making based on incomplete or erroneous data; potential for loss of endangered species population and Native American cultural resources, and significant loss of hydropower revenue due to dam constraints. AM might provide alternative protection strategies that allow the restoration of power benefits.

Limitations of AM in this case – Replication of experiments is difficult; replicate rivers are not possible and hydrology, as a master independent variable, is not entirely under program control in the regulated Colorado River and, particularly, in its tributaries. The AM program is limited geographically to boundaries that are not coincident with causative factors influencing change in condition of important resources. Responsibilities for water delivery under Colorado River water law sometimes constrain active adaptive management experiments.

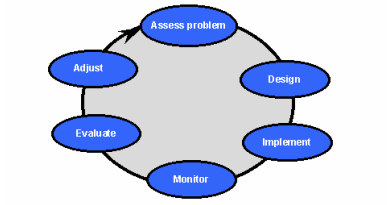
Greatest challenges or constraints that have been overcome or that remain – Competing social values (i.e., management goals & objectives) are difficult to reconcile. Stakeholder tension prevents group from fully embracing shared vision crafted by the group in FY 2000. Lack of sufficient funds increases tension among stakeholders and feeling of inequity among State and power user constituencies. Science effort would benefit from more purposeful planning. Many of the actions proposed by the Program have some degree of controversy. Historic public outreach efforts have not been sufficient. Role of NEPA within the context of adaptive management still is unclear. To date, active AM experiments have been implemented through limited scope EAs.

Time line for implementation of AM –

- 1982: Initiated environmental studies to investigate the effects of proposal to increase hydropower generation capacity at the dam.
- 1989: Initiation of NEPA EIS process on dam operations
- 1992: Passage of Grand Canyon Protection Act
- 1994: Issuance of FWS Biological Opinion on dam operations
- 1996: Experimental Beach Habitat Building Flow dam release, initiating series of active adaptive management experiments in 1997, 2000, 2003 and 2004.
- 1996: Issuance of EIS ROD. Due to controversy and disagreement among cooperating agencies, the ROD was accomplished only with a commitment for additional monitoring and research under an adaptive management paradigm.
- 1997: Organization of an adaptive management program.
- 2001: Amount of annual power revenue funding capped by appropriations bill. However, this action also secured more stable funding than might occur under the annual appropriations process.

Benefits provided by AM to date – Most of the beliefs in the scientific foundation upon which the EIS ROD was based have been shown to be false. Current research will produce better information for future decision making. Generally, stakeholders have adopted a commitment to the use of scientific learning in decision making. The Program has developed better conceptual models of integrated resource interactions. Improved dialog and understanding occurs among stakeholders, despite value differences.

Specific best management practices resulting from AM – Timing of low and high flow dam releases has been revised to conserve sediment by taking advantage of tributary inputs without negatively impacting water deliveries. Revision of fluctuating winter releases has benefited hydropower while providing control mechanism for non-native fish known to be predators of endangered native fish. There is increased recognition of and focus on multiple causative factors affecting changing resource conditions as an outgrowth of improved knowledge of how the Colorado River ecosystem functions. NPS has placed increased emphasis on resource management and protection.



Case Study: Adaptive Management of Pinedale Anticline Gas Field

Carol Kruse, Planning and Environmental Coordinator, Bureau of Land Management

Overview – In 1998, the Bureau of Land Management received a proposal from several oil and gas companies to explore and develop a new gas field in western central Wyoming. BLM determined that the reasonably foreseeable development scenario in the existing Resource Management Plan needed updating, and, thus, additional NEPA (National Environmental Policy Act) analysis was required. A third-party contractor conducted the impact analysis and wrote the EIS. The USDA-Forest Service, US Army Corps of Engineers, and State of Wyoming were granted official cooperating agency status. The National Park Service and Environmental Protection Agency also were heavily involved in the air quality impact analysis.

The new gas field begins at the Pinedale city limits and extends, in a 10-mile-wide swath, south and east for 30 miles. The project area provides unparalleled and previously "untrammeled" scenic vistas, critical habitat for world-class wildlife herds and the declining Sage Grouse, one of the few pristine settings in the United States for an intact Oregon Trail segment, extensive eligible cultural and Native American sites – and at least 9TCF of natural gas. The air and water quality in Sublette County were some of the cleanest in the United States. Three miles downwind of the proposed gas field, the Bridger and four other Class I Wilderness Areas straddle the backbone of the Wind River Mountain Range. In all, more than a dozen sensitive resources experienced significant impacts with development of the Pinedale Anticline natural gas field.

Most area residents opposed development of the gas field and became concerned when they learned the minerals had been leased decades before and the operators had valid existing rights. BLM decided that extensive public involvement in the both the planning and implementation processes would be critical to developing public acceptance for this gas field. In addition to exceptionally intensive public consultation during the planning process, BLM designed an adaptive management process that involved the public in developing and implementing monitoring plans, evaluating those results, and making recommendations to BLM regarding incremental modification of management decisions during field development. This AM process was discussed in the scoping phase and in the draft and final EISs. The structure and charge of the working group were specified in the ROD.

Unfortunately, one oil and gas company with minor involvement in the field filed a lawsuit against the decision on the grounds, among others, that BLM lacked the authority to implement AM and that the involvement of the public in AM efforts was in violation of the Federal Advisory Committee Act (FACA). Although a US District judge dismissed the lawsuit and the environmental interests intervened in the lawsuit on behalf of the BLM for probably the first time in Wyoming history, Department of Justice solicitors acknowledged that the AM working group was in violation of FACA and directed that the group be disbanded. A FACA charter has been obtained and, once members are appointed by the Secretary of the Interior, the working group will once again implement AM in the Pinedale Anticline gas field.

Management issues that were the primary drivers – (1) Uncertainties about the accuracy of impact and mitigation estimations, especially given a dearth of industry knowledge about field geology and how much development there would likely be, or where (industry projections varied from 300 wells to 3,000

wells); (2) public concern about development of a new gas field in an area highly valued by area residents and tourists for its pristine scenery, solitude, and wildlife habitats; (3) impending technological advances in both surface and subsurface mitigations.

Uncertainties that led to the AM approach being selected (i.e., the various alternate hypotheses related to the management action) – Any development in this new field was anticipated to significantly impact over a dozen sensitive resources. The NEPA process analyzed an alternatives matrix of two different numbers of producing well pads (500 or 700), two different well pad distributions within the field (evenly distributed field-wide or along the anticline crest + a few clusters off the crest), and two different mitigation scenarios (standard stipulations or additional resource protection).

Monitoring and science framework developed to support AM – The Pinedale Anticline Working Group (PAWG – an adaptive management advisory group with a substructure of six Task Groups (TG), each focused on a particularly sensitive resource) was charged with identifying useful, peer-reviewed scientific information; identifying data needs; developing appropriate monitoring plans; seeing that those plans were implemented; analyzing the monitoring data relative to the next year's drilling plans; modifying the monitoring plans for the next year if necessary; and making recommendations to BLM decision-makers regarding management prescription changes (or not) for the following year, based on monitoring results. Baseline data-gathering research projects could be designed and implemented, as well. All research designs and results were to be peer-reviewed.

Partner, stakeholder involvement versus traditional approaches – The Pinedale Anticline planning and NEPA processes were significantly more open to public input than the traditional process, from NOI through the ROD to implementation of AM . There were four formal cooperating agencies during the NEPA process (EPA, Army Corps of Engineers, State of Wyoming, USDA-Forest Service). Extensive public meetings and workshops were held throughout the scoping, alternative development, DEIS, FEIS and ROD stages of the NEPA process. This project is a prime example of "transparent decision-making." It demonstrates that "transparent decision-making" does not diminish BLM authority, but rather that it promotes customer relations, positive working relationships among interests at odds, and a sense of community for those with interests in the area (whether or not they live there). There was tremendous ownership in the Decision and in the AM process, making BLM's job easier.

Financial cost of implementing AM – The Wildlife TG was proposing baseline research and monitoring programs that would have cost $50,000 - $100,000; the Water TG recommended monitoring that is costing the operators about $75,000/year (currently being implemented because of requirements elsewhere in the ROD), and were discussing some baseline ground water research that would have been about that much again. The other TGs had not gotten that far when the process was stopped by litigation. The Field Office has a budget for FY2004 of $8,000 to support PAWG operations (the PAWG is now a FACA-chartered committee, with member appointments by the Secretary pending).

Costs or consequences of not applying AM – Under-estimation of impacts or mitigation effectiveness would result in potentially irretrievable and irreversible loss of important and/or sensitive resources/resource values; over-estimation of impacts or mitigation effectiveness would result in higher recovery costs for industry than necessary; the need for supplemental or additional NEPA analysis as the field developed would not be in either the resources' or industry's best interests; continued strong public resistance to development of the field and divisive rhetoric would make BLM's management more difficult.

Limitations of AM in this case – Wyoming does not have a RAC (Resource Advisory Council) in place, so project-specific or area-specific FACA charters may be required to implement AM with full public participation. Currently this AM process is applied only to one natural gas field, though there are other oil and gas developments occurring in this Resource Area that would benefit from this process. The

probability of having additional FACA-chartered AM committees approved in this Resource Area is low, given that the Act charges GSA with keeping the number of active FACA committees to a minimum.

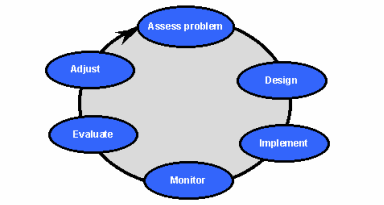
Greatest challenges or constraints that have been overcome or that remain – Interests who are traditionally at odds learned to work constructively together for the benefit of the resources. The intervening appeal/lawsuit has admittedly (by all parties) badly damaged the working relationships and the beginnings of trust that were evident prior to the lawsuit, so getting interests who are traditionally at odds to work together constructively and for the benefit of the resources is also a challenge that remains – and will be harder to meet, the second time around. Getting a FACA charter has been overcome; appointment of members remains a challenge and the charter will have to be renewed in a few months.

Timeline for implementation of AM –

- Summer 2000: AM process authorized when Pinedale Anticline ROD issued
- Fall 2000: PAWG and its six TGs organized. A company with minor holdings in the field appealed the ROD on several points, key among them were that implementation of adaptive management requires rule-making, and that the PAWG and its TGs were in violation of FACA.
- Winter 2000: PAWG's TGs functioned throughout the winter. After the 2000 Presidential election the appellant waived their right to an IBLA appeal and filed suit in US District Court.
- Spring 2001: DOJ solicitors agreed in their brief that the PAWG and its TGs were in violation of FACA; all work by those groups was stopped, and DOJ stated that no products of those groups' work would be used. BLM initiated FACA charter application process. US District Court judge dismissed the lawsuit on the grounds of failure to show harm (and verbally chided the plaintiff for interfering in a process that was working well).
- August 2002: FACA charter issued.
- February 2003: Call for FACA-chartered committee membership published in Federal Register.
- March 2004: Awaiting appointment of the members by the Secretary.

Benefits provided by AM to date – The PAWG and TG members learned that they can work together constructively, and experienced the synergy of a diverse, dynamic group working toward common goals (staying focused on the resource needs). There were many creative and innovative and effective ideas and partnerships generated by the TGs for monitoring, funding, etc., even though DOJ prevented any of those from being implemented.

Specific best management practices resulting from AM – The need/possibility of developing BMPs were being discussed by several of the TGs, but never came to fruition because the process was stopped.



Case Study: Adaptive Management of Kelp Forest, Channel Islands National Park, California

Gary E. Davis, Visiting Chief Scientist, National Park Service

Overview – Congress established Channel Islands National Park in 1980 to preserve unimpaired examples of coastal ecosystems in southern California, including more than 60,000 ha of submerged lands and waters surrounding five islands. The waters around these islands were also designated a national marine sanctuary in 1980. Because recreational and commercial fishing are allowed in park and sanctuary waters, the National Park Service and NOAA Sanctuaries instituted a cooperative adaptive management scheme with the State of California to assure that fishing opportunities and kelp forest ecosystems both were

sustained.

Since traditional single-species, surplus yield-based fishery management, assessed by monitoring fishery take alone, failed to sustain many near-shore, demersal fisheries in southern California during the 1970s, a new ecosystem-based approach was tried in the park. Beginning in 1981, population dynamics of 87 taxa (fish, invertebrates, and algae), representing a broad range of ecological roles, and sea temperatures were measured at 16 giant kelp forest sites. Traditional fishing-take data were also collected. One small area, 12 ha, was set aside from fishing as a marine reserve, and served as a control to separate the effects of fishing from the effects of pollution and normal environmental variation, such as El Niño events. After 18 years, outside of the reserve nearly 80% of the kelp forests in the park were gone, five abalone fisheries had been closed, harvestable red sea urchins were rare, and rockfish, ling cod, California sheephead and other demersal resident fishes were in jeopardy, and regional fishery closures were imminent. Hordes of overgrazing small purple sea urchins and filter-feeding brittle stars and sea cucumbers eliminated kelp following El Niño events, dominated the sea floor, and prevented kelp recovery. In stark contrast, kelp forests inside the reserve were stable and recovered quickly after El Niños, abalone populations were low, but surviving, large red urchins were common and purple sea urchins, brittle stars and sea cucumber populations remained low.

In 1999, the National Park Service and a group of local recreational anglers requested that the California Fish and Game Commission to set aside 20% of park waters in a network of marine reserves to begin rebuilding kelp forests and the fisheries they once supported. After a four-year, community-based, consensus-seeking process, and state-wide public hearings and meetings, in 2003 the Commission established 10 marine reserves in the park that constitute 19% of park waters. Monitoring the performance of these reserves will inform the next round of adaptive management.

Management issue that was the primary driver – The state owns and manages living marine resources in the park, while DOI is responsible for monitoring conditions and recommending actions to better protect park resources and achieve mandated “unimpaired ecosystems” and sustain fishing. Traditional, single-species based regulations designed to achieve maximum sustained yield failed because that approach did not account for ecological interactions (competition and predation), density-dependent reproduction, and needs for peak reproductive capacity during rare extreme natural events (El Niño). An ecosystem-based marine reserve approach is being evaluated in adaptive mode to rebuild depleted resources.

Uncertainties that led to AM approach being selected (i.e., the various alternate hypotheses related to the management action – The specific effects of pollution, invasive species, diseases and fishing on kelp forest structure and function were unknown. The hypothesis that traditional fishery management can sustain fishing opportunities and the ecological integrity of kelp forest ecosystems was falsified after a series of changes in seasons, size limits, and effort reduction failed to sustain neither fishery targeted populations nor ecosystem integrity. The size, shape and distribution of marine reserves needed to rebuild depleted populations and impaired ecosystems are unknown.

Monitoring and science framework developed to support AM – A four-step design process was used: (1) set management goals, (2) develop conceptual model of ecosystem to be managed, (3) design monitoring protocols for measuring ecological-equivalents of medical vital signs, and (4) prepare an implementation plan for funding, personnel, data management, analysis, and application. Scientists and managers from all responsible state and federal agencies and universities participated in design and implementation phases—more than 400 scientists involved during first 21 years—to reduce probability of substantive arguments about adequacy of experimental design and results of monitoring during the application phases.

Partner, stakeholder involvement versus traditional approaches – Multiple agency scientists and managers were engaged at the outset of monitoring—12 member steering committee established, led by California Fish & Game and National Park Service, met 54 times in the first 21 years. Seventeen

community representatives negotiated marine reserve design for two years with professional facilitation and expert panels for advice on MPA science and socio-economic factors, led by California Fish & Game and NOAA National Marine Sanctuary. All meetings were public, and more than 500 people attended meetings. California Fish & Game Commission conducted two additional years of public hearings statewide—more than 1,000 people participated in the meetings and hearings and more than 10,000 written comments were received during the four-year process.

Financial cost of implementing AM – Research to design and test initial ecological monitoring program: $250,000 over five years. Annual monitoring, analysis, data management and reporting: $70,000-103,000 (16-year total ~$1,280,000). Community-based, consensus-seeking negotiation to adjust management strategies: ~$1,000,000 over four years. Additional costs for governance borne by state and federal agencies—enforcement, education, administrative law reviews, public hearings, etc. Annual value of fishing and tourism businesses sustained: ~$27,000,000 (21 year total $567,000,000).

Costs or consequences of not applying AM – Consequences of not applying AM include failed fisheries, lost fishing opportunities, impaired national park ecosystems and endangerment of species.

Limitations of AM in this case – The political processes by which adjustments in management are made are complex and unpredictable. Ocean ecosystems are exceptionally dynamic, connected to numerous global driving forces, and exceedingly difficult to observe and measure.

Greatest challenges or constraints that have been overcome or that remain – Major challenges have been: gathering sufficient information about resource conditions (largely overcome), communicating resource conditions and consequences of management actions to governing bodies and critical publics (still in place), overcoming misconceptions about ocean conservation and efficacy of traditional fishery management (still in place), and understanding ecosystem dynamics well enough to predict cause—consequence relationships and system behavior (still in place).

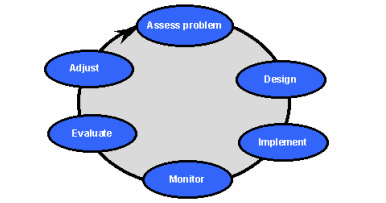
Time line for implementation of AM –

- 1981: Ecological monitoring initiated to augment fishery-dependent monitoring of take
- 1987: Request further restrictions pink and red abalone fisheries in the park
- 1988: Request closure of black abalone fishery in the park
- 1989: Request closure of all five abalone fisheries in the park
- 1990: Black abalone fishery closed at Anacapa Island
- 1991: Black abalone fishery closed at Santa Cruz Island
- 1993: Black abalone fishery closed statewide
- 1995: Pink, green, white abalone fisheries closed statewide
- 1997: Red abalone fishery closed south of San Francisco
- 1999: Request network of marine reserves in park (20%) to rebuild kelp forests and fisheries
- 2001: White abalone listed as endangered under Federal ESA
- 2003: Network of 10 marine reserves established in park (19%), monitoring program enhanced

Benefits provided by AM to date – Benefits are: reduced management costs by identifying issue while they are still tractable, increased probability of preventing irreparable damage to public resources—loss of species—by providing early warnings of depletion, increased probability of rebuilding depleted resources—fishing opportunities—by measuring responses to remedial actions, increased probability of restoring ecosystem integrity by measuring responses to management actions, and reduced conflict among people seeking access to ocean resources by providing a common information base regarding resource conditions.

Specific best management practices resulting from AM – Local communities are engaged in marine reserve design, resource allocations, and performance evaluations. The AM program measures many

facets of ecosystems managed, not just those subject to direct take, to better understand interactions among system components and a variety of human influences.



Additional Case Study: Adaptive Management of Flower Garden Banks

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Overview – The Minerals Management Service (MMS) is responsible for leasing federal lands of the outer continental shelf (OCS) for oil and gas exploration and development. As industry began planning for operations in the deep water of the Gulf of Mexico in the early 1970s, MMS began writing EISs for lease sales and created an environmental studies program to support analyses. Studies documented, among other things, thriving coral reef communities at the unique "Flower Garden Banks" (FGB) in the northwestern Gulf of Mexico. Recognizing the need to ensure the protection of these reefs in the face of uncertain impacts, MMS sponsored the first "multiple-use" meeting in 1973, which brought together the oil and gas industry, the general public, academia and private contractors. This and numerous other meetings and public hearings culminated in several mutually agreeable concepts to protect the reef communities, including stipulations for monitoring and adaptive environmental management.

The MMS “stipulation” specified the protective measures. The stipulation became a part of the lease document and thus was binding on the lessee. The stipulation for the FGB established a no activity zone (NAZ) and a four mile "shunt" zone. The NAZ, where no activities can take place, protects the bank's biota from mechanical damage due to drilling, platform and pipeline emplacement, and anchors. The shunt zone, in which all effluent from the drilling process must be shunted to near the sea floor, was designed to prevent drilling discharge from reaching the bank's unique biota. As part of the stipulation, lessees had to monitor environmental conditions at production sites and at the banks themselves under strict MMS guidelines.

As more was learned about the banks through the studies program and monitoring, the stipulation was modified to reflect the best possible information, and the provisions of the latest stipulation applied to appropriate blocks regardless of the older stipulation in the lease. After several years and numerous monitoring reports, MMS knew no damage was being done to the banks or the coral habitat. MMS showed great flexibility at this time in reducing the stipulation for compliance monitoring at production sites. At the same time, MMS recognized the need to continue to monitor the condition of living reefs. It became clear that the banks were being severely damaged from sports fishing and commercial vessels anchoring on the shallow coral reefs. Marine scientists from an environmental group, the Gulf Reef Environmental Action Team (GREAT), conceived of a way to prevent anchor damage while not discouraging visitors. MMS provided personnel to help GREAT install 12 anchor moorings at the banks, so vessels can tie up easily and not drop anchor.

MMS developed a multi-disciplinary long-term monitoring program for the FGB, initially costing over $1 million per year. As further information was gathered and analyzed, the program was refined to reduce the number of cruises and dives, cutting annual costs to about $200,000. Performing these reductions in a stepwise fashion assured MMS received the information necessary to monitor the health of the banks. In 1992, the FGB were designated a National Marine Sanctuary. Responsibility for protection of the reefs passed to the National Oceanic and Atmospheric Administration (NOAA) although MMS continues a cost-sharing agreement with NOAA. In 1994, the NOAA National Marine Sanctuary Program presented a

recognition award to MMS for over 20 years of commitment to resource protection and funding of surveys and research at the FGB. In May 1996, MMS won the Fourth Annual Federal Environmental Quality Award for its outstanding NEPA program, given jointly by the Council on Environmental Quality and the National Association of Environmental Professionals.

Management issue that was the primary driver – The primary driver for developing a FGB monitoring program was the protection of this unique and possibly fragile coral reef environment as offshore oil and gas development activities and other human uses increased in the area.

Uncertainties that led to AM approach being selected (i.e., the various alternate hypotheses related to the management action – Management actions related to environmental protection and offshore oil and gas activities include avoidance of areas for all industry activities as well as the development of mitigation measures such as lease stipulations for activities to be conducted in or near areas of concern. There were uncertainties concerning the nature, extent and causes of impacts to corals in the FGB as well as effective mitigation. Monitoring helped resolve these uncertainties and MMS was able to adapt management accordingly.

Monitoring and science framework developed to support AM – As discussed above, the monitoring framework is based on repeated sampling of corals and other faunal components of the FGB system to determine "health," and sampling of physical and chemical parameters to assist in the interpretation of biological results.

Partner, stakeholder involvement versus traditional approaches – The NOAA National Marine Sanctuary Program is a partner and stakeholder. Other stakeholders include sport fishers and SCUBA divers who use the FGB. They are used as additional sources of information through established observer programs. Although it has since dissolved, GREAT was an important partner in terms of adapting better strategies of protection.

Financial cost of implementing AM – Monitoring at the FGB is approximately $200,000/year with costs equally shared by MMS and the NOAA National Marine Sanctuary Program. Total cost from 1970's to present is over $3,000,000.

Costs or consequences of not applying AM – Monitoring results have shown that the living corals of the FGB remain healthy and growing. Long-term monitoring has confirmed and continues to validate the present understanding that lease stipulations provide effective mitigation of potential impacts from oil and gas operations. The cost of not applying AM could be a degraded coral reef system.

Limitations of AM in this case – The FGB characterization studies and monitoring were not developed as an application of AM.

Greatest challenges or constraints that have been overcome or that remain – The greatest challenge is maintaining priority for the continued funding of research and monitoring of the FGB after 20+ years of completed studies. Truly "long-term" studies are always difficult to justify for continued support.

Time line for implementation of AM – - Initial studies were conducted in the late 1970's and early 1980's to characterize the biological communities and physical environment of the FGB and other topographic features in the central and western Gulf of Mexico. This characterization was needed to serve as a basis for future monitoring designed to detect any potential impacts related to offshore oil and gas activities or other human uses of the FGB such as fishing and SCUBA diving. Actual monitoring with repeated sampling of established stations using a set sampling protocol began in the late 1980's.

Benefits provided by AM to date – - Continued health of the living coral reefs of the FGB. There has also been a benefit to the agency – MMS has received two environmental protection awards in recognition of

the FGB studies and the resulting adaptive management applied to offshore oil and gas lease management decision-making.

Specific best management practices resulting from AM – Recognition of importance of verifying the effectiveness of mitigation measures that are applied to offshore oil and gas leases. In the FGB case, field monitoring has provided verification.